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ETCHING DEVICE

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Claim

An etching device characterized by the fact that in an etching device that provides a substrate to be processed to one of the electrodes arranged opposite each other with a prescribed space in between, makes the processing gas into a plasma by impressing electric power between the electrodes, and uses a computer to control the process for etching the substrate to be processed with this processing gas made into a plasma, it is composed with a means for inputting

the sensor output indicating the processing state into the computer and a means for composing the sensor output thus obtained into a graph and displaying it on a screen.

Detailed explanation of the invention

Objective of the invention

Industrial application field

The present invention relates to an etching device.

Prior art

Among devices for etching various thin films that can simplify the complex process of manufacturing semiconductor elements, can automate the process, and moreover, can form fine patterns with high precision, a plasma etching device which utilizes the reaction components in the gas plasma has been attracting attention in recent years.

This plasma etching device is provided with an aluminum electrode at the bottom of an airtight container connected to a vacuum device, for example, an aluminum electrode body is provided, with an electrode made of amorphous carbon being provided at the top to oppose the aforementioned aluminum electrode, an RF power source is connected to this amorphous carbon electrode and aforementioned aluminum electrode, and electric power is impressed between the electrodes from the aforementioned power source by setting a substrate to be processed, for example, a semiconductor wafer, on the aforementioned aluminum electrode. At the same time, a necessary processing gas is fed between the aforementioned electrodes. This processing gas is then converted into plasma by means of the aforementioned electrode power, and the surface of the aforementioned semiconductor wafer is etched with this processing gas that was converted into plasma.

In this type of etching device, many automated devices are provided for loading the wafer into the reaction vessel from the cassette and executing plasma etching; the information for monitoring and control of the operating state of the automated device is input via various sensors provided to each device into a control device that controls the plasma etching, and is fed back to the aforementioned many devices after being converted into control information. In the conventional etching device, the part of the information that controls and monitors these operating states was displayed only as character information.

Problems to be solved by the invention

However, in LSI, super LSI, etc, a large volume of various information was necessary to determine the processing conditions for obtaining the optimum etching rate in order to form ultra-fine patterns with high precision, to verify the reproducibility, and to control the lot, and

with the conventional output of only character information, there were problems from errors in reading the information and from analysis and discrimination of the aforementioned information not being possible in a short time. The present invention was made taking these factors into consideration, and provides an etching device that allows quick verification of reproducibility, lot control, etc. because errors are immediately found upon viewing the information or discrepancy information, and analysis and judgement can be made quickly so that determination of the process reproducibility and lot control becomes easy by comparing graphs, etc., even for someone who is not a technician with specialized knowledge.

Constitution of the invention

Means to solve the problems

The invention is characterized by the fact that in an etching device which provides a substrate to be processed to one of the electrodes arranged opposite each other with a prescribed space in between, makes the processing gas into a plasma; by impressing electric power between the electrodes, and uses a computer to control the process of etching the substrate with the processing gas made into a plasma, it comprises a means for inputting the sensor output characterizing the processing state into the computer and a means for composing the sensor output thus obtained into a graph and displaying it on a screen.

Operation and effects

Since an etching device which provides a substrate to be processed to one of the electrodes arranged opposite each other with a prescribed space in between, converts the processing gas into a plasma by impressing electric power between the electrodes, and uses a computer to control the process for etching the substrate with the processing gas converted into a plasma, was equipped with a means for inputting the sensor output characterizing the processing state into the computer and a means for composing the sensor output thus obtained into a graph and displaying it on the screen, it is possible to compose a large volume of various kinds of information for analyzing and determining the reproducibility of the process or for finding the process condition to obtain the optimum etching rate into a graph and to display it, thereby preventing erroneous reading of the character information that tends to occur when the display shows only a large volume of characters, enabling easy discovery of discrepancies and quick analysis of and judgement concerning the aforementioned large volume of various kinds of information in a short time, making determination of process conditions and verification of reproducibility easy, so the process can be controlled and changed properly, and greatly reducing the process loss time. Also, comparative examination becomes easy, even for a person who is not a technician with specialized knowledge, because of displays of displays of graphs, etc., lot

control and determination of process reproducibility becomes possible, and control becomes easy even for persons other than specialized technicians.

Application example

Below, an application example, in which the device of the present invention is applied to an etching device in the semiconductor manufacturing process, will be explained, with reference to the figures.

As shown in Figure 1, a device, for example, a plasma etching device, that etches and processes a substrate to be processed, for example, a semiconductor wafer (1), is constituted of a loader/unloader device comprised of storage part (2) that stores aforementioned wafer (1), transport part (3) for transporting aforementioned wafer (1) in and out of storage part (2), alignment part (4) for positioning wafer (1) from transport part (3), processing part (5) that etches and processes wafer (2) positioned with aforementioned alignment part (4), and operation part (6) that executes control of the operation and monitoring of these parts.

To explaining the loader/unloader part first, aforementioned storage part (2) can store plural, for example, two wafer cassettes (7) capable of stacking and storing plural pieces, for example, 25 semiconductor wafers (1), by providing a prescribed space in the thickness direction. This wafer cassette (7) is mounted on corresponding cassette mounting stand (8) and this cassette mounting stand (8) is capable of moving vertically by means of the respective independent elevating mechanism not shown in the figure. Here, it is preferable for the aforementioned elevating mechanism to always be positioned below aforementioned cassette mounting stand (8), as a corrosion preventive measure.

Also, multi-jointed robot (9) that transports wafer (1) is provided to transport part (3) between aforementioned storage part (2), alignment part (4), and treatment part (5). Arm (10) provided with a holding mechanism, for example, a vacuum pickup mechanism not shown in the figure, is provided to multi-jointed robot (9), and this arm (10) is formed from a material such as ceramic or quartz that prevents heavy metal contamination of wafer (1). Also, this multi-jointed robot (9) can rotate freely with one point as an axis and can move in the horizontal-axial direction. Also, vacuum chuck (11) is provided to alignment part (4) that positions wafer (1) transported by aforementioned transport part (3). This vacuum chuck (11) is comprised of a disc-shaped inner chuck and a ring-shaped outer chuck that is spaced a prescribed distance from the outer circumference of the inner chuck. The aforementioned inner chuck can move vertically and rotate, with the center of the inner chuck as the axis, and the aforementioned outer chuck can move in the horizontal-axial direction. Also, a sensor, for example, a transmission type sensor, which is capable of moving toward the center of the inner chuck and detects the wafer outer

circumference, is provided. As was noted above, the loader/unloader device is comprised of storage part (2), transport part (3), and alignment part (4).

Then, processing part (5), which processes wafer (1) positioned with aforementioned alignment part (4), is constituted. This processing part (5) is provided in processing chamber (12) for executing an etching process with plural, for example, 2 systems of inside load lock chamber (13) and outside load lock chamber (14) capable of transporting wafer (1) while maintaining airtightness and spare chamber (15) for multi-purpose use to execute treatments such as light etching, ashing, etc. on wafer (1) after processing is connected to outside load lock chamber (13). Open/close mechanism (16a) is provided to aforementioned inside load lock chamber (13) by forming an inlet for wafer (1) in one side wall on the aforementioned alignment part (4) side and open/close mechanism (16b), which makes isolation from aforementioned processing chamber (12) possible, is provided to the opposite surface from the open/close mechanism (16a).

Then, handling arm (17a), which transfers wafer (1) to processing chamber (12) from alignment part (4) is provided inside load lock chamber (13). Also, for aforementioned outside load lock chamber (14), open/close mechanism (18a) that makes isolation from processing chamber (12) possible is provided in one side wall on the aforementioned processing chamber (12) side, and open/close mechanism (18b) that makes isolation from spare chamber (15) possible is provided in the side wall on the spare chamber (15) side adjacent to open/close mechanism (18a). Also, handling arm (17b), which executes transfer of wafer (1) to spare chamber (15) from reaction processing chamber (12), is provided to outside load lock chamber (14). A vacuum exhaust mechanism, for example, a rotary pump not shown in the figure is connected to aforementioned load lock chambers (13) and (14), and furthermore, a purge mechanism, not shown in the figure, is provided that is capable of introducing an inactive gas, for example, N_2 gas. Then, in aforementioned processing chamber (12), the inside part made of Al and applied with a surface alumite treatment is formed into a cylindrical shape. At the bottom of this processing chamber (12), bottom electrode body (20) linked to elevating mechanism (19) is provided to elevate freely, and airtightness is maintained with bellows (21) made of a material, for example SUS, in correspondence with the elevation thereof. This bottom electrode body (20) has a plate shape and is made of, for example, aluminum that is applied with an alumite treatment on the surface. The top surface of bottom electrode body (20) that holds semiconductor wafer (1) is formed into an R, and this is tilted from the center towards the periphery.

Also, a synthetic high molecular weight polymer film, for example, 20-100 μm of heat resistant polyimide resin that is not shown in the figure, is provided between bottom electrode body (20) and the semiconductor wafer (1) mounting surface by adhering it to the semiconductor wafer (1) mounting surface of bottom electrode body (20) with a heat resistant acrylic resin adhesive so as to make the impedance uniform between semiconductor wafer (1) and the

electrode that holds this semiconductor wafer (1), namely, bottom electrode body (20). Then, through-holes (not shown it the figure), oriented vertically are formed in aforementioned bottom electrode body (20) at, for example, four places and lifter pins (22) capable of elevating freely are provided within these through-holes. These lifter pins (22) are made, for example, with SUS, and plate (23) connected to four lifter pins (22) is synchronized by operation of elevating mechanism (24). In this case, aforementioned plate (23) is forced downward by coil spring (25) if elevating mechanism (24) is not operating, and the extreme ends of aforementioned lifter pins (22) descend from the bottom surface of electrode body (20). Also, a cooling gas conduit is connected to the aforementioned through-holes and this cooling gas conduit is linked to the plural, for example, 16 apertures (not shown in the figure) provided in the bottom electrode body (20) surface positioned at the peripheral part of aforementioned semiconductor wafer (1). A cooling gas introduction pipe is provided at the bottom part of processing chamber (12) and is linked to a cooling gas supply source not shown in the figure so that a cooling gas, for example, helium gas, can be fed to the back surface of semiconductor wafer (1) from these apertures and the aforementioned through-holes.

Also, passage (26) is provided within the cooling mechanism, for example, bottom electrode body (20), and when electrode power is applied to aforementioned bottom electrode body (20), cooling is achieved by means of circulation of a cooling fluid, for example, a mixture of antifreeze fluid and water, with a fluid cooling device (not shown in the figure) linked to piping (not shown in the figure) connected to this passage (26), in order to improve uniformity in the etching process. Then, exhaust ring (28) provided with 36 exhaust holes (27) equally arranged at a prescribed angle, for example, at 10° intervals, with a diameter of, for example, 5 mm, within the space between the side part of bottom electrode body (20) and the inside surface of aforementioned processing chamber (12), is fixed to the side wall of processing chamber (12), and the exhaust gas inside processing chamber (12) is exhausted freely by means of a connected exhaust device, for example, a turbo molecular pump and a rotary pump, via exhaust pipe (29) connected to the side of the processing chamber (12) below exhaust ring (28), etc. In order to mount and fix semiconductor wafer (1) to this kind of bottom electrode body (20), clamp ring (30) is provided so that it presses against wafer (1) when bottom electrode body (20) ascends. Clamp ring (30) is constituted to ascend to a prescribed height, for example, 5 mm, while maintaining a prescribed pressure when wafer (1) contacts this clamp ring (30) and electrode body (20) is raised. Specifically, clamp ring (30) holds plural shafts of, for example, high purity Al_2O_3 that penetrate the top part of processing chamber (12) while maintaining a seal via, for example, four air cylinders (31). Aforementioned clamp ring (30) is adapted to the diameter of semiconductor wafer (1) in order to press the peripheral part of aforementioned semiconductor wafer (1) to the surface of bottom electrode body (20) formed into an R. This

clamp ring (30) is, for example, made of aluminum, has an alumite treatment applied to its surface, and provides an insulating alumina covering on the surface by means of this alumite treatment. Then top electrode body (32) is provided at the top part of processing chamber (12) opposite bottom electrode body (20). This top electrode body (32) is made of a conductive material, for example, aluminum with alumite treatment applied to its surface, and a cooling means is provided to this top electrode body (32). This cooling means comprises, for example, passage (33) that runs inside top electrode body (32), is linked to a cooling device (not shown in the figure) provided outside aforementioned processing chamber (12) via piping (not shown in the figure) connected to this passage (33), and has a structure by which a fluid circulates, for example, a mixture of antifreeze fluid and water, that is maintained at a prescribed temperature. Top electrode (34) made of, for example, amorphous carbon, is provided to the bottom surface of this top electrode body (32), and is electrically connected state to said top electrode body (32). A slight space (35) is formed between this top electrode (34) and top electrode body (32), gas supply pipe (36) is connected to this space (35), and this gas supply pipe (35) is composed to freely supply a reaction gas, for example, CHF_3, CF_4, etc. and a carrier gas, for example, Ar, He, etc., to aforementioned space (36) from the gas supply source (not shown in the figure) outside aforementioned processing chamber (12) via a flow rate adjuster, for example, a mass•flow controller, not shown in the figure. Also, plural baffles (37), which have plural apertures for diffusing the gas equally, are provided to this space (35).

Then, plural holes (38) are formed in top electrode (34) so as to lead out reaction gas, etc., diffused by baffles (37), to the inside part of processing chamber (12) via said top electrode (34). Insulation ring (39) is provided at the periphery of this top electrode (34) and top electrode body (32), and shield ring (40) is arranged to extend to the bottom peripheral surface of said top electrode (34) from the bottom surface of this insulation ring (39). This shield ring (40) is formed with an insulator, for example, of ethylene tetrafluoride resin, approximately the same diameter as the substrate to be processed, for example, semiconductor wafer (1) to be etched, so that the plasma can be controlled. Also, high frequency power source (41) is provided for impressing high frequency electric power to aforementioned top electrode body (32) and bottom electrode body (20). Then, open/close mechanism (15a) is provided to aforementioned spare chamber (15) on the multi-jointed robot (9) side, a purge mechanism that introduces an inactive gas, etc. and an exhaust mechanism not shown in the figure are provided to prevent lifting, etc. of wafer (1) due to the pressure differences from the atmosphere with opening and closing thereof, and a mounting stand, not shown in the figure, for transferring wafer (1) is provided that can elevate. Then, operation part (6) is provided to monitor the wafer processing state and to control the operation of each mechanism constituted as described above. This operation part (6) is comprised of control part (42), which executes arithmetic processing of various information, and operation

display part (43), which executes monitoring, etc. and is composed with software written in, for example, C language.

Aforementioned control part (42) is composed to allow individual activation or operation or serial activation or operation of aforementioned operation display part (43), storage part (2), transport part (3), alignment part (4), and processing part (5) or for input control of information from various sensors (not shown in the figure) provided at each state monitoring position. This type of control (42) is comprised of controller (44) that executes arithmetic, comparison, and other processes within control part (42), memory part (45) that stores the information processed in controller (44) and information from the sensors or operation display part (43), and timer (46) that measures the duration of the etching process.

Then, operation display part (43) is comprised of display part (47), for example, a CRT that displays the information from control part (42), and input part (48), composed of plural input means, for example, keyboard, IC card, etc., that inputs information from operation display part (43) into control part (42).

The various sensors provided at the aforementioned state monitoring positions consist of the following kinds.

For example, there is a barratron gage that measures and detects the vacuum pressure within processing chamber (12), high frequency generator that detects the reflected energy or power consumption of high frequency electric power impressed on electrodes (20) and (34), rotary encoder that measures and detects the space between bottom electrode body (20) and top electrode (34) within processing chamber (12), mass flow controller that controls and detects the gas flow rate of the several gases flowing within processing chamber (12), platinum temperature measurement resistor that independently measures and detects the temperature of bottom electrode body (20) and the temperature of top electrode (34) within processing chamber (12), barratron gage that measures and detects the clamp pressure of the clamp for adhering and fixing wafer (1), which is the substrate to be processed, to bottom electrode body (20) within processing chamber (12), mass flow controller that measures and detects the flow rate of the cooling gas, for example, He gas, introduced to cool the back surface of aforementioned clamped wafer (1), monochromator that determines the completion of etching from the specific reflected light within processing chamber (12), etc.

Next, the operation and function of the aforementioned etching device will be explained.

First of all, wafer cassette (7) loaded with about 25 wafers is mounted on cassette mounting stand (8) for reloading by operator, robot hand, etc., and empty wafer cassette (7) is mounted on cassette mounting stand (8) for unloading. Then, wafer (1) is moved vertically by means of the elevating mechanism and installed at the prescribed position. Simultaneously, multi-jointed robot (9) is moved and positioned at wafer cassette (7) for loading. Then, arm (10)

of multi-jointed robot (9) is inserted under necessary wafer (1). Then, cassette mounting stand (8) is lowered by a prescribed amount and wafer (1) is vacuum grasp by arm (10). Next, arm (10) is extended to transport and mount it on vacuum chuck (11) of alignment part (4). Here, centering of said wafer and positioning of the orifura [transliteration] is executed. At this time, an inactive gas, for example, N_2 gas, has already been introduced into inside load lock chamber (13) and pressurized. Then, open/close mechanism (16a) of inside load lock chamber (13) is opened while introducing N_2 gas, wafer (1) positioned with handling arm (17a) is transported to aforementioned inside load lock chamber (13), then open/close mechanism (16a) is closed. Then, the inside of this inside load lock chamber (13) is evacuated to a prescribed pressure, for example, 0.1-2 torr. At this time, treatment chamber (12) also has already been evacuated to a prescribed pressure, for example, 1×10^{-4} torr. Open/close mechanism (16b) of inside load lock chamber (13) is opened in this state and wafer (1) is transported into processing chamber (12) with handling arm (17a). In accord with this transport operation, lifter pins (22) ascend at a speed of, for example, 12 mm/S, by means of elevating mechanism (24) from the through-holes of bottom electrode body (20). With these lifted, wafer (1) is installed and left stationary on top of each lifter pin (22). Thereafter, aforementioned handling arm (17a) is stored within inside load lock chamber (13) and open/close mechanism (16b) is closed. Then, bottom electrode body (20) within processing chamber (12) is raised a prescribed amount by elevating mechanism (19) so as to mount wafer (1) on, for example, bottom electrode body (20). Furthermore, bottom electrode body (20) is continuously raised at a low speed, contacted to clamp ring (30), and is raised by a prescribed amount, for example, 5 mm, while maintaining a prescribed pressure. The gap between bottom electrode body (20) and top electrode (34) is accordingly set at a prescribed spacing, for example, 6-20 mm. Exhaust control is executed during the aforementioned operation and the necessary gas flow and exhaust pressure settings are verified. Thereafter, a reaction gas, for example, CHF_3 gas 100SCCM or CF_4 gas 100SCCM, and a carrier gas, for example, He gas 1000SCCM, Ar gas 1000SCCM, etc. are equally rectified by means of baffle (37) provided to space (35) of top electrode body (32) via gas supply pipe (36) from the gas supply source while controlling exhaust so as to maintain the inside of processing chamber (12) at 2-3 torr, and these are made to flow out to semiconductor wafer (1) via plural holes (38) provided to top electrode (34). At the same time, high frequency electric power with a frequency of, for example, 13.56 MHz, is impressed between top electrode (34) and bottom electrode body (20) from high frequency power source (41) to convert the aforementioned reaction gas into plasma and, for example, anisotropic etching of aforementioned semiconductor wafer (1) is executed with this reaction gas converted into plasma. At this time, top electrode (34) and bottom electrode body (20) reach a high temperature due to the application of high frequency electric power. When top electrode (34) becomes hot, thermal expansion is naturally generated. In this case, top electrode

(34) is made of amorphous carbon and top electrode body (32), which contacts this, is made of aluminum, so the coefficient of thermal expansion differs and cracks are generated. In order to prevent this generation of cracks, a mixture of antifreeze fluid and water is pumped by a cooling means (not shown in the figure) that is linked by piping to passage (33) inside top electrode body (32), and it indirectly cools top electrode (34). Also, if bottom electrode body (20) becomes hot even the semiconductor wafer (1) becomes hot, so there is concern about generating defects by damaging the resist pattern formed on the surface of semiconductor wafer (1). Therefore, bottom electrode body (20) is also cooled by pumping a mixture of antifreeze fluid and water from a cooling device (not shown in the figure) of a separate system linked via piping to passage (26) formed in the bottom part, in the same manner as top electrode (34). This cooling water is controlled to be, for example, about 0-60°C, in order to process the aforementioned semiconductor wafer (1) at a fixed temperature. Also, semiconductor wafer (1) is heated by the thermal energy of the plasma, so a cooling gas, for example, helium gas is fed to the back surface of semiconductor wafer (1) from the cooling gas supply source (not shown in the figure) via plural, for example, 16 apertures at the periphery and 4 through-holes near the center formed in bottom electrode body (20), the cooling gas conduit, and the cooling gas introduction pipe. At this time, the aforementioned apertures and through-holes are sealed by the position of semiconductor wafer (1). However, in actuality there is a very small space between the surface of bottom electrode body (20) and semiconductor wafer (1) due to surface coarseness, etc., and said semiconductor wafer (1) is cooled by feeding said helium gas into this space. Etching is executed for a prescribed time, for example, 2 min, while maintaining these conditions. Then, bottom electrode body (20) is lowered while exhausting the reaction gas, etc. in processing chamber (12) upon completion of this process, and wafer (1) is placed on lifter pins (22). Then, the pressure within processing chamber (12) and outside load lock chamber (14) is made about the same and open/close mechanism (18b) is opened. Next, handling arm (17b) provided to outside load lock chamber (14) is inserted into processing chamber (12), aforementioned lifter pins (22) are lowered, and wafer (1) is grasped and mounted on handling arm (17b). Then, handling arm (17b) is stored within outside load lock chamber (14) and open/close mechanism (18a) is closed. At this time, spare chamber (15) has already been evacuated to be about the same as outside load lock chamber (14). Then, open/close mechanism (18b) is opened and wafer (1) is stored on mounting stand, not shown in the figure, within spare chamber (15) by means of handling arm (17b). Then, open/close mechanism (18b) is closed, the mounting stand is lowered and open/close mechanism (15a) of spare chamber (15) is opened.

Next, multi-jointed robot (9) is moved to a position prescribed beforehand, arm (10) of this multi-jointed robot (9) is inserted into spare chamber (15), and wafer (1) is grasped and mounted on arm (10). Then, arm (10) is transported, multi-jointed robot (9) is rotated by 180°

while moving to the prescribed position when open/close mechanism (15a) of spare chamber (15) is closed, and wafer (1) is transported and stored at the prescribed position in empty cassette (7) by means of arm (10). The aforementioned series of operations is executed with regard to all wafers (1) stored in cassette (7).

Next, the aforementioned operation will be explained using Figures 3 and 4 by focusing on the information processing in operation part (6).

Substrates to be processed, for example, wafers (1), are placed in storage part (2) in wafer cassette units [step] (50), the temperature of top and bottom electrodes (20) and (32) in processing part (5), the temperature of the side wall of processing chamber (12), the detection method of, for example, the end point for determining etching process completion, etc., are established by process condition setting [step] (51) from input part (48) in operation display part (43), and then stored in memory part (45). Next, in process procedure setting [step] (52), procedures for the order, the combination, and the duration of, for example, maintenance of pressure within processing chamber (12) of processing part (5), application of high frequency electric power, delivery of processing gases such as reaction gas, carrier gas, etc. are stored in memory part (45) from input part (48). Next, when the start switch, not shown in the figure, of operation display part (43) is pushed [step (53)], wafer (1) is transported by means of transport part (3) composed of, for example, multi-jointed robot (9), etc., not shown in the figure, from wafer cassette (7) placed in storage part (2), [step] (54) then mounted and set within processing chamber (12) of processing part (5) [step] (55). Next, setting is executed in process condition setting [step] (51), the process condition stored in memory part (45) and actual information from the sensor that is detecting the processing condition in processing part (5) are compared [step] (56), and if the condition is not satisfied, processing part (5) is controlled by controller (44) until the actual information from the sensor satisfies that condition, so that it becomes the set process. Then when the condition is satisfied, cooling gas for cooling wafer (1) is introduced, a processing gas such as is indicated in the process procedure, for example, flow is introduced [step] (57) according to the instructions stored in memory part (45) which were entered in process procedure setting [step] (52), high frequency electric power is applied, and the etching process is started. Then etching is executed until end point detection is made by means of, for example, the average value end point detection method that was specified in process condition setting [step] (51), using the information of a sensor, for example, a monochromator, in the processing part [step] (58). Then when end point detection [step] (59) is made, cooling gas for cooling wafer (1) stops. Simultaneously, for example, in-flow of the processing gas is stopped and application of high frequency electric power is stopped [step] (60) according to the procedure set in process procedure setting [step] (52).

Next, wafer (1) is stored in cassette (7) for storing in storage part (2), by means of transport part (3) composed of multi-jointed robot (9), with the completion of the etching process in processing part (5). Then, the operations subsequent to pressing the start switch are repeated until all wafers (1) stored in wafer cassette (7) for loading are completed as in flow [step] (63).

Here, the outputs of various sensors, which detect the aforementioned processing states, can be displayed at the necessary time. Specifically, as shown in Figure 5, whether or not to display is selected from the keyboard in operation display part (43). Next, display is desired, the processing state is selected from the keyboard in operation display part (43) [step] (65). Then, the selected processing state is incorporated in control part (42) [step] (66). Here, arithmetic processing is executed on the incorporated information and the graphing process is executed [step] (67). Then the result of the graphing process is displayed in display part (47) [step] (68).

This display is a voltage conversion display by means of a graph with, for example, the voltage on the vertical axis and the time on the horizontal axis, as shown in Figure 6. This display state continues as long as there is no indication from the keyboard of input part (48). The resolution of the display data is a cycle of, for example, 200 mS. Here, when an indication of display completion is executed from the keyboard in input part (48), it is reset and returns to the original state. Also, a closed loop is composed so as to return again to the original state if "not to display" is selected in aforementioned selection [step] (64).

As noted above, the processing state of the device is displayed in display part (47) in real time as a graph of the necessary sensor data.

As was noted above, according to this working example, since an etching device that provides a substrate to be processed to one of the electrodes arranged opposite each other with a prescribed space in between, converts the processing gas into a plasma by impressing electric power between the electrodes, and uses a computer to control the process for etching the substrate to be processed with this processing gas converted to a plasma was equipped with a means for inputting sensor output detecting the processing state into the computer and a means for composing the sensor output thus obtained into a graph and displaying it on the screen, it is possible to compose a large volume of various kinds of information, for analysis and determination of the reproducibility of the process or for finding the process conditions in order to obtain the optimum etching rate, into a graph and display it, to prevent erroneous reading of character information that tends to occur when only a large volume of characters is displayed, to find discrepancies easily, to analyze and categorize the aforementioned large volume of various kinds of information quickly, to make finding process conditions and verification of reproducibility easy, to set and adjust the process properly, and to greatly reduce the process loss time. Also, displays of graphs, etc., make comparative examination easy even for a person who is not a technician with specialized knowledge, lot control and determination of process

reproducibility become possible, and control becomes easily possible even by persons other than specialized technicians.

This invention is not restricted to the aforementioned working example, and can be applied to semiconductor manufacturing devices such as CVD or sputtering devices that deposit, for example, a required thin film on a substrate to be processed, ashing devices that carbonize the resist, etc.

Furthermore, needless to say, it can be applied to a device that manufactures LCD substrates used for image display devices such as liquid crystal TV, etc.

Brief description of the drawings

Figure 1 is a block diagram of an etching device explaining a working example of the semiconductor device in the present invention, Figure 2 is an explanatory diagram of the processing part of the device in Figure 1, Figure 3 is a block diagram explaining the constitution of the operation part, Figures 4 and 5 are flow charts explaining Figure 3, and Figure 6 is a working example of the display shown in the display part of Figure 5.

(5)...processing part, (42)...control part, (43)...operation display part, (44)...controller, (45)...memory part, (46)...timer.

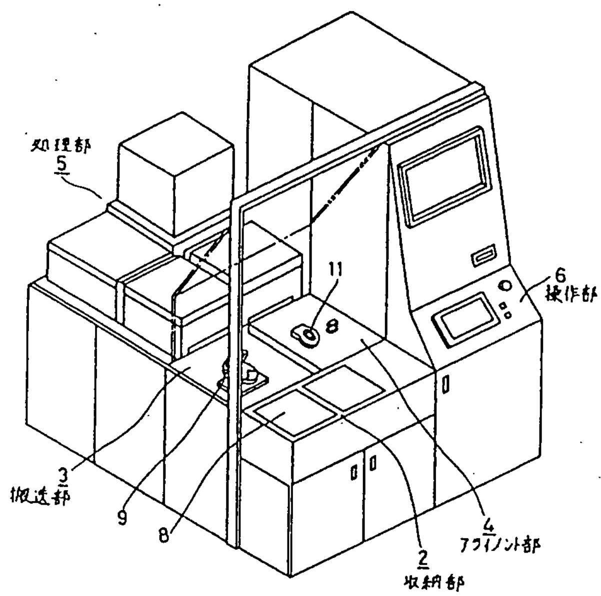

Figure 1(A)

Key: (2) Storage part
(3) Transport part
(4) Alignment part
(5) Processing part
(6) Operation part

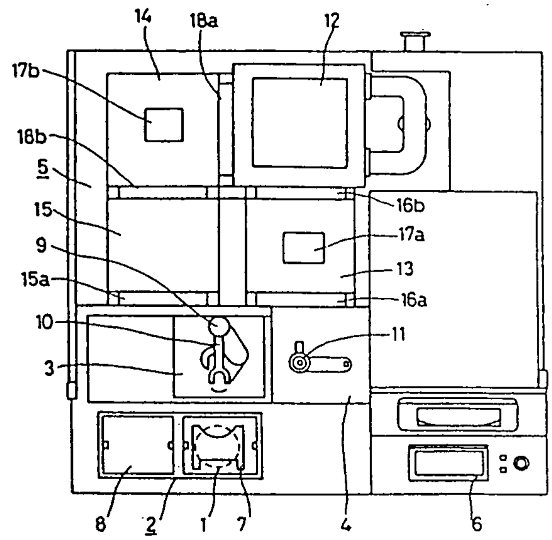

Figure 1(B)

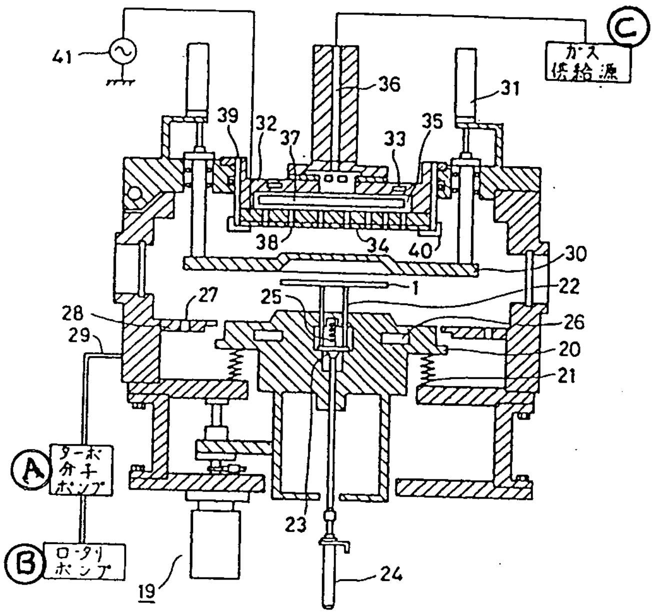

Figure 2

Key: A Turbo molecular pump
B Rotary pump
C Gas supply source

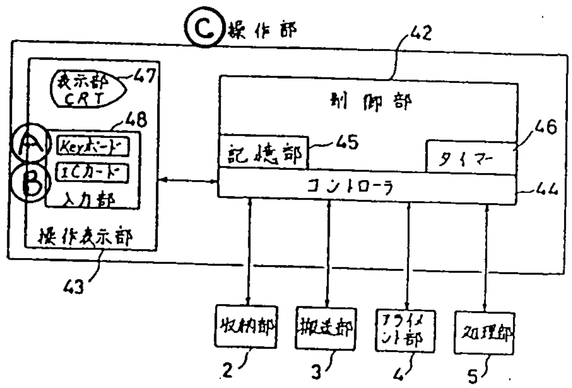

Figure 3

Key:

Key:	A	Keyboard
	B	IC card
	C	Operating unit
	(2)	Storage part
	(3)	Transport part
	(4)	Alignment part
	(5)	Processing part
	(42)	Control part
	(43)	Operation display part
	(44)	Controller
	(45)	Memory part
	(46)	Timer
	(47)	Display part
	(48)	Input part

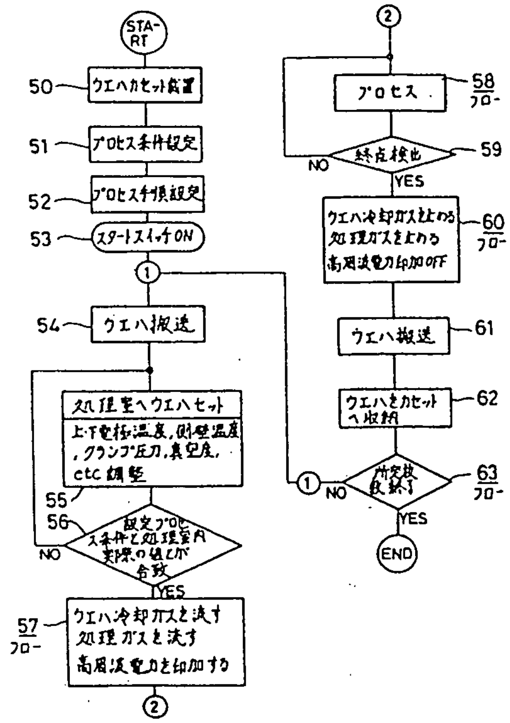

Figure 4

Key:
50 Mount wafer cassette
51 Set the process condition
52 Set the process procedure
53 Turn ON start switch
54 Transport wafer
55 Set wafer in the processing chamber
Adjust the top and bottom electrode temperature, sidewall temperature, clamp pressure, degree of vacuum, etc.
56 The set process condition and the actual value within the processing chamber correspond
57 (Flow) Wafer cooling gas is introduced
Processing gas is introduced
High frequency electric power is applied
58 (Flow) Process
59 Detection of end point
60 (Flow) Wafer cooling gas is stopped
Processing gas is stopped
High frequency electric power is turned OFF
61 Transport of wafer

62 Storage of wafer in cassette
63 (Flow) Prescribed number of wafers completed

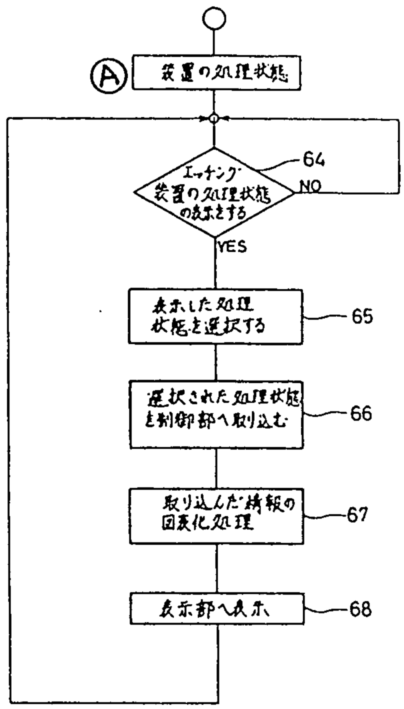

Figure 5

Key:
A Processing state of the device
64 Display the processing state of etching device
65 Select the displayed processing state
66 Incorporate the selected processing state in the control part
67 Compose the incorporated information into a graph
68 Display in the display part

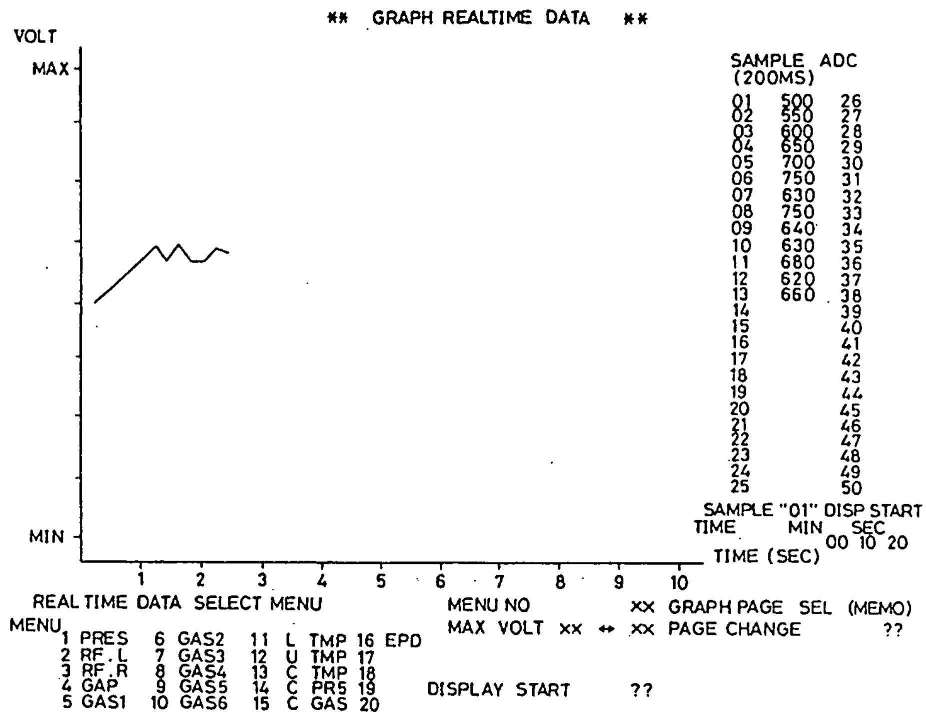
** GRAPH REALTIME DATA **
VOLT
MAX
MIN
SAMPLE ADC
(200MS)
01 500 26
02 550 27
03 600 28
04 650 29
05 700 30
06 750 31
07 630 32
08 750 33
09 640 34
10 630 35
11 680 36
12 620 37
13 660 38
14 39
15 40
16 41
17 42
18 43
19 44
20 45
21 46
22 47
23 48
24 49
25 50
SAMPLE "01" DISP START
TIME MIN SEC
00 10 20
TIME (SEC)
1 2 3 4 5 6 7 8 9 10
REAL TIME DATA SELECT MENU
MENU
1 PRES 6 GAS2 11 L TMP 16 EPD
2 RF.L 7 GAS3 12 U TMP 17
3 RF.R 8 GAS4 13 C TMP 18
4 GAP 9 GAS5 14 C PR5 19
5 GAS1 10 GAS6 15 C GAS 20
MENU NO xx GRAPH PAGE SEL (MEMO)
MAX VOLT xx ↔ xx PAGE CHANGE ??
DISPLAY START ??

Figure 6